NSW Department of Commerce
NSW Water Solutions

Nomination of
BATHURST SEWAGE TREATMENT PLANT
as a
National Engineering Landmark

16 April 2008

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National Engineering Landmark

Prepared by Guy Boncardo
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Will Strachan and Fred King
for
NSW Department of Commerce
Office of Public Works and Services

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Contents

This document has been prepared by Guy Boncardo, BE, MEngSc, FIE (Aust), CPEng. Guy is the Principal Engineer of the NSW Department of Commerce's Wastewater Services Section and has been closely involved with investigation and design of works at the Bathurst Sewage Treatment Plant since 1986.

1.0 INTRODUCTION

The Bathurst Sewerage Scheme collects, transports and treats sewage generated within the City of Bathurst and its major urban (domestic and industrial) sewerage catchments (Eglington, Perthville, Raglan and Bathurst City).

The Sewage Treatment Plant (STP) is an integral part of the Scheme, providing high level treatment of sewage inflows and allows its owner, Bathurst Regional Council, to return treated effluent and stabilised biosolids to the environment in a sustainable manner with minimal environmental impact.

In the context of NSW Country Towns infrastructure, the Plant is a large sized facility performing a critical role in the protection of public health, the local Bathurst environment and the environment of downstream communities along the Macquarie River, into which treated effluent is discharged.

As with many Australian regional centres in the mid to late nineteenth century, establishment of the Scheme was in response to public health concerns with the impact of unregulated and poorly managed sewerage discharges. The Plant was established at its current location in 1916 in parallel with the initial provision of reticulated sewerage services in the main urban area of Bathurst. Since that time Council, in partnership with the NSW Public Works Department (now incorporated within the Department of Commerce – Office of Public Works and Services), has undertaken a number of significant augmentations of plant capacity to allow for:

- domestic/residential and industrial growth within the city
- increasingly stringent regulatory requirements for (the quality of) effluent reused or discharged to receiving waters, and biosolids disposed to the environment or reused.

To address these requirements a number of sewage treatment technologies were successively implemented at Bathurst between 1916 and 1996. These represent the suite of technologies that were developed and utilised in both Country NSW and the Sydney Metropolitan Area.

Normally, as treatment plants are upgraded the redundant structures are demolished and new ones constructed in their place. However, at Bathurst all the structures constructed since 1916 still exist, although the original septic tanks have been buried, and while the 1929 aeration tanks have been largely demolished a significant portion of these structures remain. The Plant therefore provides an excellent example of the evolution of treatment technologies in the twentieth century and is thus a unique resource for research into sewage treatment technologies and the types of engineering structures employed.

In addition, the Plant was the focus of a number of significant research initiatives which led to the development and implementation by the Public Works Department of the most commonly utilised sewage treatment process in NSW, Intermittent Decanted Extended Aeration.

The Plant, and upstream sewerage reticulation and transfer system, have been critical to the wellbeing of the Bathurst community since 1916, by providing an amenity essential for urban living. Perhaps more importantly, it has also provided protection of public health and the local and downstream environment from the potential negative impacts of sewage and effluent discharges. The Plant currently receives and treats sewage flows of about 10ML/d to a standard acceptable for discharge to the Macquarie River receiving environment.

As detailed in this submission, the Plant exhibits many features of engineering heritage significance. Based on the evaluation of these, it is recommended that it be declared a National Engineering Landmark.

2.0 NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: Bathurst Sewage Treatment Plant

The above-mentioned work is nominated to be awarded a National Engineering Landmark

Location: Morrisset Street, Bathurst

Owner (name & address) Bathurst Regional Council
Russell Street
Bathurst NSW 2795

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site: Access to the Plant is via Morrisset Street Bathurst. Directions for access to a particular component should be obtained from Council's Manager, Bathurst Water and Waste Authority, David Swan.

Nominating Body: NSW Department of Commerce, Office of Public Works and Services

....

Group General Manager, NSW Water Solutions

Date: 9.5.08

This plaquing nomination is supported and is recommended for approval.

....

Chair of Division Engineering Heritage Group

Date: ....

BATHURST REGIONAL COUNCIL

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Bathurst NSW 2795

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7 November 2007

Mr Guy Boncardo
Principal Engineer Wastewater Services
New South Wales Department of Commerce
McKell Building
2-24 Rawson Place
SYDNEY NSW 2000

Dear Sir

Plaquing Nomination for Bathurst Sewerage Treatment Plant

Council is appreciative of the Department of Commerce's efforts in proposing the nomination of Bathurst Sewage Treatment Plant as an historic engineering site. We understand that Engineering Heritage Australia would now welcome a nomination.

The site retains the elements from each stage of augmentation of the plant since its initial establishment in 1916, representing the evolution of sewage treatment technologies in the twentieth century. These have included the:

- original septic tank treatment system (1916)
- initial (1929) and subsequent (1959) trickling filtration system augmentations
- the 1978 augmentation based on the then innovative Intermittent Decanted Extended Aeration (IDEA) system, which was first implemented at Bathurst as a deep vertical reactor configuration – and later became known as the "Bathurst Box"
- subsequent (1980) augmentation in which four additional Bathurst Boxes were provided
- trialling and retrofitting of Biological Phosphorus removal (BioP) facilities to the original Bathurst Box (1990-95), being the first such application of these facilities in NSW
- provision of two significant Bathurst Boxes provided with (BioP) in 1995
- implementation of major effluent balancing and (Ultraviolet Irradiation) disinfection facilities in 1997.

Since the initial development of the Bathurst Box, that IDEA technology has been applied at 67 locations in NSW, benefiting the communities served and assisting in protection of the receiving environment.

Council is proud of:

- its role in providing sewerage services to the Bathurst community
- facilitating the evaluation of treatment technologies, consistent with changing treatment standards throughout the twentieth century

Reference: DS:MO:21.00018
Enquiries: Mr David Swan 02 6333 6290

- its current proposals to further enhance its (IDEA) treatment system with the incorporation of membrane technologies to further enhance the level of treatment achieved and maximise the production of reclaimed water for beneficial reuse.

Accordingly, Council is in agreement with a nomination being made by the NSW Department of Commerce for the award of an historic engineering plaque, and is cooperating in its preparation.

Yours faithfully

David Sherley
GENERAL MANAGER

3.0 LOCATION OF BATHURST STP

The Plant is located 3km to the north west of the centre of Bathurst adjacent to the Macquarie River, as shown in **Figure 1**. Buffer distance to residential development, immediately to the west of the Plant, is about 100m.

Figure 1 Bathurst Sewage Treatment Plant Location

1. Influent Lift Pumping Station “Engine House” (1916)
2. Septic Tanks and Filters – buried (1916 – filters subsequently converted sludge drying beds – 1950’s)
3. Trickling Filter and Aeration Tanks (1929)
4. Trickling Filter Plant (1959)
5. Sludge Storage Lagoons (1974)
6. Original Bathurst Box (1976)
7. Inlet Works and Lift Pumping System (1979)
8. BioP IDEA Reactors (1997)
9. Effluent Balancing Ponds (1997)
10. Chemical Storage and Dosing System (1997)
11. Waste Activated Sludge Balancing and Dewatering System (1997)
12. Laboratory (1994)
13. Effluent Lift Pumping and Ultraviolet Irradiation Disinfection System (1997)
14. Macquarie River

4.0 GLOSSARY, ABBREVIATIONS AND UNITS

4.1 Glossary

Activated Sludge	-	A high concentration of microorganisms present as a floc suspended by mechanical agitation
Aerobic	-	A condition in which dissolved oxygen is present
Anaerobic	-	A condition in which there is no dissolved oxygen
Anoxic	-	A condition in which dissolved oxygen is significantly depleted
Biochemical Oxygen Demand	-	A measure of the oxygen required by microorganisms to break down organic matter
Biological Reactor	-	A container in which activated sludge is stored and sewage introduced for treatment
Comminution	-	Maceration of organic and inorganic solids
Denitrification	-	The removal of oxidised nitrogen compounds within an oxygen starved environment, producing nitrogen gas
Disinfection	-	The removal of residual pathogenic organisms from treated sewage effluent
Equivalent Person	-	A measure of hydraulic and biological load produced by a person contributing to a sewerage scheme
Mixed Liquor Suspended Solids	-	The concentration of solid constituents within activated sludge contained in a biological reactor
Nitrification	-	The oxidation of nitrogen compounds (in the presence of oxygen) producing more stable compounds
Sewage	-	Wastewater derived from domestic and industrial sources containing organic and inorganic solid and liquid pollutants
Sewer Mining	-	Extraction of sewage from a sewage transport system and its treatment for beneficial reuse purposes
UniFed	-	A system configured to distribute influent flow uniformly over the base of a biological reactor

4.2 Abbreviations and Units

ADWF	Average Dry Weather Flow
BCC	Bathurst City Council
BioP	Biological Phosphorus Removal
BOD	Biochemical Oxygen Demand
BRC	Bathurst Regional Council
DPWS	Department of Public Works and Services
EP	Equivalent Persons
GAO	Glycogen Absorbing Organisms
mg/L	Milligrams per Litre
ML/d	Megalitre per Day
MLSS	Mixed Liquor Suspended Solids
NSW	New South Wales
PAO	Polyphosphate Absorbing Organisms
PWD	Public Works Department
STP	Sewage Treatment Plant

5.0 HERITAGE ASSESSMENT

5.1 Basic Data

Item Name:	Bathurst Sewage Treatment Plant
Other/Former Names:	Nil
Location:	
Address:	The Plant location is off Morrisset St Bathurst bordered by the Macquarie River to the north east. It is administered by Bathurst Regional Council, whose offices are at Russell St, Bathurst NSW 2795.
Suburb/Nearest Town:	NA
State:	New South Wales
Local Govt. Area:	Bathurst
Owner:	Bathurst Regional Council
Current Use:	Treatment of sewage generated by domestic and industrial sources within the City of Bathurst.
Former Use (if any):	NA
Designer:	Public Works Department NSW
Maker/Builder:	Public Works Department NSW
Year Started:	1915
Year Completed:	Latest structure completed in 2002
Physical Description:	• Original Influent Pump House – good • Original Influent and Septic Tanks – poor (buried) • Original Aeration Tanks – partly demolished • Original and Augmented Trickling Filters – good • Original Sludge Lagoons – good • Original Bathurst Box Activated Sludge Reactor – excellent • Other Bathurst Box Reactors – excellent • Waste Activated Sludge Balancing and Dewatering System – excellent • Effluent Balancing Ponds – excellent • Effluent Disinfection System – excellent
Modifications and Dates:	See Section 5.2.2
Historical Notes:	See Section 5.2.1
Heritage Listings:	Nil

5.2 Heritage Significance

5.2.1 Historic Phase

From the granting of self-government to New South Wales in 1856 and until 1880, the provision of sewerage and drainage services remained the responsibility of municipalities.

Between 1874 and 1876 there was a severe drought in NSW and there were numerous outbreaks of typhoid fever and epidemics of measles and diphtheria, largely due to poor drainage/disposal of sewage and resultant contamination of water courses. This was often exacerbated by frequent failure of water supply systems, which was the case in Bathurst. In some unsewered inner Sydney suburbs up to half the children died in the epidemics. A similar epidemic occurred at Bathurst (**Ref 14).**

As a consequence, in 1876 the eminent English engineer William Clark was brought to Sydney to advise on suitable water supply and sewerage works. He also advised on works for Newcastle and a number of major country towns, including Bathurst.

The Country Towns Water Supply and Sewerage Act was passed in July 1880. It provided for the NSW Government to borrow funds and construct water supply and sewerage works on behalf of municipalities, with the Minister for Public Works as the constructing authority.

In March 1906 the Bathurst Council resolved to provide a scheme to *serve every house in the Borough and that a treatment depot should be located outside the city boundary* (**Ref 5).** This resolution was forwarded to the Public Works Department for consideration. In December 1909 the proposal was referred to the Public Works Committee, which visited Bathurst in July 1910 and approved the Scheme in August of that year.

The proposed Scheme was based on a gravity reticulation system which collected and transferred sewage to the treatment plant site 3km north east of the Borough and adjacent to the Macquarie River. Council's proposed treatment method was based on the Liemur Septic Tank System, commonly adopted in new sewerage schemes in NSW at that time.

Implementation of the Scheme commenced with survey in March 1911 and awarding of a tender for construction to O'Meara Brothers in September 1912 for £45,237. The Scheme was completed at the end of 1915, together with the Water Supply Scheme. There are significant parallels in the history of both Schemes, which have been well documented by Sloman (**Ref 5).**

The construction of reticulated water supply and sewerage systems by the Public Works Department (PWD) in Sydney and major country towns between 1880 and 1930 produced dramatic improvements in public health. Over this period the NSW death rate due to water borne diseases was halved and infectious disease and infant mortality rates were reduced by a factor of ten (**Ref 16**). From 1935 similar works were funded under the Country Towns Water Supply and Sewerage Program which was administered by the Department up until 1995, when management of the Program transferred to the then Department of Land and Water Conservation (now Department of Water and Energy).

Since its initial establishment, the capacity of the Bathurst Plant has been progressively increased in response to growth within the City's sewerage catchments and the requirement for higher standards for effluent discharged to the Macquarie River. This has involved use of a number of treatment technologies, which are representative of those that evolved during the twentieth century. Works undertaken and related issues pertinent to the Plant's engineering heritage, are described below.

5.2.2 Progressive Implementation of Sewage Treatment Technologies

The implementation of sewage treatment technologies at Bathurst parallels the development of those in the twentieth century. The chronology of implementation is generally as follows:

1915/16 - Influent pumping station, septic tanks with filter bed, including Imhoff Tanks.

1928/29 - Trickling filtration, including primary and secondary sedimentation, digestion and pre-aeration.

- Provision of sludge storage lagoons.

1959/60 - Additional trickling filtration units, including influent (sewage) receival works with grit and screenings removal and solids comminution, anaerobic digestion, primary and secondary sedimentation and chlorination of effluent discharged from all treatment systems.

1974/76 - Sludge storage lagoons and "Bathurst Box", 4000EP capacity activated sludge reactor based on Intermittent Decanted Extended Aeration (IDEA), decommissioning of septic tanks, conversion of original filter beds to sludge drying beds.

1979/80 - Provision of an additional four 4,000EP IDEA units. Decommissioning of effluent chlorination system, provision of detention ponds for effluent disinfection, new influent lift pumping station and inlet works.

- Provision of new influent lift pumping and screening system, decommissioning of (1959/60) influent receival works.

1992 - Provision of mechanical sludge thickening and dewatering system.

- Decommissioning of sludge lagoons and drying beds.

Figure 2 Original Engine House (Influent Pumping Station) Located within Timber Building (1916)

1993/94 - Full scale trial retrofit of the original "Bathurst Box", based on addition of anoxic and anaerobic chambers for biological phosphorus removal (BioP).

1996/97 - Provision of two additional (17,500EP each) IDEA BioP reactors, conversion of effluent detention ponds to balance ponding system, provision of effluent lift pumping and artificial ultraviolet irradiation system.

- Decommissioning of trickling filtration units, including primary and secondary sedimentation tanks and sludge digesters.
- Provision of on-site testing laboratory.

2002 - Provision of Dissolved Air Flotation Waste Activated Sludge Thickening System.

Septic Tanks

The original Bathurst plant comprised a conventional septic tank system, commonly used in municipal applications from the late nineteenth century. It included four Imhoff Tanks for removal of gross solids, incorporating a digester for their stabilisation, a trickling filter bed for the further treatment of the effluent produced and an effluent outfall main to the Macquarie River. Sewage was able to be gravitated to the plant, given the relatively low elevation of the site, being located on the floodplain adjacent to the Macquarie River. To allow transfer to the treatment system, a lift pumping station (denoted the "Engine House" on the original drawings) was provided (**Figure 2).** This comprised a below ground dry well in which centrifugal lift pumps and discharge pipework were located. To balance incoming flows, two below ground storage wells were provided immediately upstream of the station, to which suction pipework was connected. The "Engine House" included an above-ground building over the drywall, which is still in a sound structural condition and utilised by Council for equipment storage. The capacity of this system is unknown. However, Sloman (**Ref 5**) reports the Bathurst population at about that time being 9,000 people, indicating a system capacity of that order.

The Imhoff and septic tanks have been largely demolished and their remnants buried within an open area of the plant (**Figure 3**), a portion over which sludge drying beds were constructed (circa 1950).

Figure 3 Original Septic Tanks and Filters (1915) Converted to Sludge Drying Beds (Circa 1950)

Trickling Filtration Units

Due to Bathurst's growing population, an augmentation was constructed by the PWD for Council in 1929 comprising two additional primary sedimentation tanks, a trickling filter bed, over which settled sewage (primary effluent) was distributed by rotating arms driven by the jetting action of the flow, and two secondary sedimentation (humus) tanks. These units, which operated in parallel with the original plant, were typical of those provided by the PWD during the 1920s and 1930s. Trickling filter-based treatment was state-of-the-art technology at that time and numerous similar plants were provided in NSW under the Country Towns Water Supply and Sewerage Program.

The augmentation included two chambers upstream of the primary sedimentation tanks in which the sewage was aerated. These units have been largely demolished, although still well visible (**Figure 4).** The use of pre-aeration (prior to primary sedimentation) was unprecedented at that time. Its intention is still unclear, although it was likely to have been provided to allow enhanced treatment by pre-aeration. Design drawings of the 1959 augmentation by the Department denote these structures as the "Existing Activated Sludge Plant", indicating that they were possibly used as aeration units until at least that time.

With continued growth of the city another augmentation was required by 1958. The resulting works comprised a significantly larger trickling filter plant which included a new inlet works. A new influent lift pumping station was provided to allow gravity flow from the inlet works through the plant. This comprised constant velocity grit removal chambers, a Parshall Flume for control and measurement of incoming flow, a bar screen for removal of gross solids and a comminutor for their maceration. Secondary treatment units included two trickling filter beds, three primary sedimentation tanks, two trickling filters (**Figure 5**), two secondary sedimentation (humus) tanks, two anaerobic digesters for stabilisation of solids settled within the primary sedimentation tanks (sludge), a chlorination system for secondary effluent disinfection and a contact tank.

Figure 4 Mass Concrete Walled Aeration Tanks (1929)

With effluent from the original 1916/29 plant transferred to the chlorination system, the three plants were then operated as parallel treatment systems, except for the original septic tanks, Imhoff tanks and influent storage tanks, which were then utilised for storm flow detention.

Thus by 1960 Bathurst had an integrated trickling filter sewage treatment system constructed in three stages, with a capacity of 1,300,000 gallons per day (dry weather flow) or 26,000 equivalent persons (EP).

All structures provided in the 1959 augmentation, although now decommissioned, are in good physical condition.

Figure 5 Augmented Trickling Filters (1959)

Intermittent Decanted Extended Aeration

By 1975, when further augmentation was required, the PWD was developing a more compact configuration of the 1m deep Pasveer Channel, Intermittently Decanted Extended Aeration (IDEA) activated sludge treatment system. This system had initially been developed in the early 1960's based on the oxidation racetrack ditch concept developed by Dr Pasveer in the Netherlands. This evolved into a deeper box configuration in a project at Bathurst funded jointly by the Federal Government and the Bathurst-Orange Development Corporation. The resulting (3m) reactor developed by the Department became known as the "Bathurst Box". It was a novel variant of the Pasveer Channel due to its deeper (3m) rectangular configuration, resulting in secondary treatment for 4,000EP being able to be achieved in an area occupied by the relatively shallow (1m) Pasveer Channel racetrack of 2,000EP capacity.

IDEA was a variant of the activated sludge treatment process, which was being developed internationally. The process is based on treatment via a concentrated suspension of microorganisms within an aerated reactor. These reactors provide conditions suitable for enhanced nitrogen removal by nitrifying and denitrifying micro-organisms, ie of ammonia and oxidised nitrogen forms. A higher degree of removal of carbonaceous pollutants is also achieved than in a trickling filtration system. IDEA was a novel enhancement of the conventional activated sludge process in that primary and secondary treatment was able to be realised in one (rather than three) treatment units. Conventional activated sludge systems

typically required provision of primary and secondary sedimentation tanks in addition to the biological reactor. To achieve significant nitrogen removal a recycle stream was typically provided to a separate anoxic chamber located upstream of the reactor. The simplicity of IDEA enabled significant capital economy to be achieved as well as operational simplicity, and accounts for its wide application in NSW from the late 1960's. The standard 3m deep box-type biological reactor was developed by the PWD as a full scale trial treatment unit, sized for 4,000 persons. It was constructed at Bathurst, to provide the additional treatment capacity required. The original "Bathurst Box" (**Figure 7)** was extensively trialled in 1977-78 prior to being adopted at other country towns.

Figure 6 Original Electrical Control Panel for Influent Pump Station (1959)

A 1977 report by the Department's eminent sewerage Senior Technical Officer, Reg Clarke, who, together with the Department's wastewater engineers Bob Hulton, Russ Lloyd and Merv Goronzy, is widely credited with design and trialling of the Pasveer Channel in NSW, details the results of these trials and concludes (**Ref 11**):

- "the plant is easy to operate and even now, except in high winds, is performing at least as well as the best trickling filter plants
- in terms of capital cost, $42 per capita, it is very competitive and is cheaper than a Pasveer Channel
- there is no doubt that the prototype is a very significant development in sewage treatment, not only for Australia, but internationally".

The innovative "Bathurst Box" allowed both primary and secondary treatment (including clarification) to be achieved within a single compact biological reactor treatment unit. Its configuration was based on extended aeration, that is a "food starved" regime, where the mass of micro-organisms within the reactor is significantly higher than the mass of pollutants (BOD) in the influent sewage. This configuration allows achievement of a significantly higher degree of treatment (particularly in relation to nitrogen removal) than conventional trickling filtration systems and early conventional activated sludge treatment systems, which were not sized as extended aeration units. The successful application of the "Bathurst Box" allowed further development to a more economical in-ground sloping wall configuration at Port Macquarie in 1978. This was later known as the "Port Macquarie Tank". The latter was

more suited to sites with less area constraints and impervious in-situ subgrade.

To date twenty eight "Bathurst Box" treatment plants have been provided in NSW, as well as thirty nine "Port Macquarie Tank" plants. These include three major plants for Sydney Water Corporation ("Port Macquarie Tanks" at Picton and West Camden and "Bathurst Boxes" at Penrith). In addition the Department has designed three IDEA ("Bathurst Box") plants for the West Australian Water Corporation and one for Emerald Shire Council (in Queensland), as well as three plants in Sabah and one in China.

Figure 7 Original "Bathurst Box" (1976)

Development of the "Bathurst Box" was critical to the later implementation of the IDEA treatment system in NSW. Following a review of practical options for plant augmentation in 1977 (**Ref 9**), an additional four Boxes were provided at Bathurst in 1980, increasing plant capacity to 46,000 EP.

All "Bathurst Box" units are in excellent physical condition and operational.

Biological Phosphorus Removal

The requirement for more stringent effluent quality in NSW, particularly in relation to phosphorus levels, primarily to mitigate the impact of effluent discharges in inland receiving waters, provided the catalyst for the development of biological and chemical phosphorus removal systems in the 1980s. Biological phosphorus removal (BioP) in activated sludge treatment systems typically required the provision of additional anoxic and anaerobic reactor chambers with internal MLSS recycle systems to provide conditions conducive to the preferential growth of Polyphosphate Absorbing Organisms (PAOs), over Glycogen Absorbing Organisms (GAOs). As a consequence, the PWD, in conjunction with Bathurst City Council and the Department of Land and Water Conservation developed a project to retrofit the original "Bathurst Box" to achieve BioP.

This project's timing coincided with the (then) world's largest algal bloom, which occurred within the Darling-Barwon River System. In his December 1992 "Statement of the Environment" the Prime Minister announced the National Landcare Program, which included measures to improve the quality of water in the Murray-Darling Basin. Control of nutrient levels (particularly phosphorus) in inland rivers was considered a critical measure for

implementation. Due to its size and location at the head of the Macquarie River, Bathurst was considered a priority centre for implementation of phosphorus removal (**Ref 1**).

Figure 8 Emptied B4000 Reactor with Diffused Aeration System (Left) and Operational Reactor with UniFed Influent Distribution System (Right)

The project was preceded by installation and monitoring of a pilot biological reactor of 150EP capacity at the plant in which conditions were varied by manipulating operating cycles. The three year (1989-92) Pilot Study confirmed that significant biological (in lieu of chemical) removal of polyphosphates could be achieved within an IDEA reactor via the provision of separate upstream anoxic and anaerobic zones (chambers) to facilitate the conversion of phosphorus within influent sewage solids to soluble polyphosphate form, and for polyphosphates to be absorbed by micro-organisms within the reactor (PAOs).

A parallel Strategy Study by the Department (**Ref 6)** based on results of the pilot plant monitoring study, confirmed that Biological Phosphorus Removal (BioP) was the most cost effective method of phosphorus removal at Bathurst, where BioP is enhanced by the high strength and septicity of influent sewage due to significant organic industrial waste discharges (which comprise about 30 percent of inflow to the plant) and detention within the sewage transfer system.

The adopted strategy was based on retrofitting the original "Bathurst Box" with upstream external anoxic and anaerobic chambers (reactors), an internal Mixed Liquor Suspended Solids (MLSS) recycle system and separate prefermentation reactor. The retrofit project was funded by the Council, the NSW Department of Land and Water Conservation and Commonwealth Department of Primary Industries and Energy.

The retrofit was designed by the Department (PWD) in 1993 and constructed in 1994. It effectively comprised a full scale trial of an IDEA biological reactor configured for BioP removal (**Figure 9**). Extensive monitoring of the reactor's performance was undertaken between October 1994 and October 1995 (**Ref 1**). This confirmed the practicality of achieving BioP within IDEA reactors and the relative economy of IDEA BioP in comparison

to BioP achieved with conventional continuously, rather than intermittently, aerated reactors.

Figure 9 Prefermentation and Anoxic/Anaerobic Chambers Retrofitted to Original "Bathurst Box" (1995)

Monitoring confirmed the practicality of BioP retrofit and that significant phosphorus removal could be achieved in IDEA treatment systems without the use of chemicals and separate reactor chambers, resulting in significant economy in IDEA BioP applications in NSW.

Additional IDEA BioP Augmentation

Following the success of the full scale BioP trial, Council resolved that the next augmentation to the Bathurst treatment plant would be based on construction of two additional IDEA BioP reactors. These were designed and constructed by the Department in 1995-96. Each reactor was of 17,500 EP capacity (**Figures 10, 11** and **12**), effectively increasing plant capacity to 55,000 EP and allowing the trickling filter treatment stream to be decommissioned. This simplified operation and maintenance and allowed the level of treatment to satisfy current requirements for discharge to sensitive inland waters, such as the Macquarie River, to be achieved. The 1996 augmentation included conversion of the effluent disinfection ponds to a new effluent-balance ponding system. An ultraviolet irradiation disinfection system to which effluent is delivered via a lift pumping station (**Figure 13**) effectively replaced the existing ponds as the effluent disinfection mechanism.

The development and implementation of IDEA BioP at Bathurst was a significant catalyst to its adoption at Penrith, where two 40,000 EP capacity reactors were provided for Sydney Water Corporation in 2002, based on the Department's design concept. Process and hydraulic design parameters derived via the pilot and full scale trials undertaken at Bathurst were pertinent to configuring the Penrith reactors. This included the inclusion of anoxic-anaerobic chambers upstream of the main (aerobic) reactor, and an MLSS recycle system whose capacity could be varied to maximise denitrification potential.

Figure 10 Surface Aeration System within B17500 Biological Reactor

Achievement of significant biological (rather than chemical) phosphorus removal (BioP) in activated sludge reactors is important, as significant operational cost savings are achieved due to the reduction in chemical usage required to reduce phosphorus to a level consistent with discharge requirements to inland receiving waters (typically 0.3 to 1.0mg/L). At Bathurst, BioP allows phosphorus levels to be reduced from 10-12mg/L (within the influent sewage) to 2-3mg/L, requiring chemical addition only for the residual phosphorus, resulting in significant savings in chemical usage and associated costs. Development of IDEA BioP at Bathurst allowed confirmation that IDEA systems could be configured for BioP. Prior to the 1994 trials at Bathurst, BioP was only able to be achieved in continuous activated sludge process configurations, based on research and development largely undertaken in South Africa in the 1960s and 1970s. IDEA BioP allows significant capital and recurrent economies to be realised, due largely to the simplicity of the IDEA process and reactor configuration, which obviates the need for multiple units to achieve secondary treatment.

The IDEA BioP reactors at Bathurst are significant as being the first ever such system trialled and implemented as full scale treatment units.

International Recognition

The Department's efforts in development and implementation of IDEA systems in NSW have been recognised by the International Water Association (IWA) (**Ref 15**). The IWA states "The development of IDEA systems in the early 1970's has had a major impact on the widespread application of this technology in NSW…". Research and development at Bathurst was critical to this benchmarking recognition.

Figure 11 Anoxic Anaerobic Prefermentation Chamber in B17500 BioP Reactors (1996)

5.2.3 Current facilities (in 2008)

Facilities at the Plant currently include:

- Original Septic Tanks and Rock Filters (1916) – these have been buried but can be easily exposed for inspection, if required
- Original (1929) Trickling Filter and Aeration Tanks –not operational
- Trickling Filter Plant (1958) – not operational
- Sludge Storage Lagoons (1974) – not operational
- 5 x 4,000 EP capacity Bathurst Boxes (1980) including one IDEA BioP Reactor – operational and are fitted with a UniFed influent distribution system (1999)
- 2 x 17,500 equivalent persons (EP) capacity biological phosphorus removal (BioP) "Bathurst Boxes" (1997) – operational
- Ancillary Works – operational and in excellent condition comprise:
  - Influent Lift Pumping Station (1980)
  - Inlet Works/Flow Divider (1980)
  - Waste Activated Sludge Storage and Mechanical Dewatering System (1992)
  - Effluent Balance Ponds (1998)
  - Effluent Lift Pumping Station (1998)
  - Ultraviolet Irradiation Effluent Disinfection System (1998)
  - Laboratory/Amenities Buildings (1997)
  - Dissolved Air Flotation Sludge Thickening System (2002).

These facilities effectively represent the suite of sewage treatment technologies and related systems which were developed, and implemented, in NSW during the twentieth century. It is important to note that their contribution to the wellbeing of the Bathurst Community is well established and is ongoing.

Figure 12 Effluent Decanting Troughs in B17500EP Biological Reactors (1996)

5.2.4 Research Potential – Teaching and Understanding

All structures constructed on the site (since 1916) still exist, although the original septic tanks have been buried (but could be exposed), and while the 1929 aeration tanks have been largely demolished a significant portion of these remains. The Plant therefore provides an excellent example of the evolution of treatment technologies in the twentieth century and is thus a unique resource for research into sewage treatment technology and the types of engineering structures employed.

Since 1987, when monitoring by the Department (PWD) indicated a high degree of (biological) phosphorus removal in the IDEA reactors at Bathurst (**Ref 7**) the Plant has been the focus of extensive research into sewage treatment and development activities relating to:

- enhancement/modification of IDEA for BioP removal (via the addition of anoxic and anaerobic reactor chambers, 1993, 1997 (**Refs 1, 7**)
- development of a modular transportable IDEA reactor for application in small sewerage schemes and/or sewer mining, (1997) (**Ref 12**). The system developed is utilised at the John Morony Correctional Centre, producing 150kL/d of high quality reclaimed water and has significant potential in urban reuse and "sewer mining" applications
- further enhancement of BioP via provision of a distributed influent feed system (UniFed) to optimise anoxic/anaerobic conditions within a B4000 biological reactor, (1999-2000) (**Refs 3, 10** and **13**). This research was undertaken in conjunction with the Cooperative Research Centre for Waste Management and Pollution Control, and established the feasibility of deletion of external anoxic/anaerobic reactors and internal recycle streams to allow conditions conducive to BioP to be created within IDEA reactors
- the integration of membrane technologies with the IDEA process, 2007 (**Ref 2**). Integration utilises the hydraulic attenuation/balancing features of IDEA, overcoming the significant hydraulic restriction of membrane systems, allowing production of a

constant urban non-potable reuse quality reclaimed water stream, without influent bypass during wet weather inflows. This is now being considered as an integral component of the Ballina Urban Water Management Strategy.

The (seven) operational IDEA rectors are diverse in their configuration. All could be well utilised for additional sewage treatment research and development relating to IDEA, ie:

- Reactor 1 (the original "Bathurst Box"), has in place an upstream prefermentation reactor, multiple internal recycle streams, and upstream prefermentation and anoxic/anaerobic reactors. These could be utilised to widely vary operating conditions within the reactors to allow further optimisation of the BioP process to be explored
- Reactor 5 (retrofitted with the distributed influent feed UniFed system in 1999 and trialled for enhanced BioP removal) presents an opportunity for the further development of UniFed, particularly for the treatment of high strength wastes and as an aerobic waste activated sludge stabilisation process
- Reactors 6 and 7 (the 17,500EP units constructed as Biological Phosphorus Removal systems) present an opportunity for the examination of IDEA system hydraulic modelling parameters for non chemically dosed reactors configured specifically for BioP removal, due to the likely difference in MLSS characteristics in these reactors.

In addition, decommissioned units such as the (1959) sludge digesters present an opportunity for the pre-treatment of high strength industrial wastes, prior to their introduction into the IDEA reactor system, to be researched. Initial investigations were undertaken in 1997, in conjunction with the University of Queensland (**Ref 8**) and could be expanded to include the range of organic waste derived from industries in Bathurst.

Figure 13 Effluent Lift Pumping and UV Disinfection System (1997)

5.2.5 Social or cultural

From its implementation in 1916 the Bathurst Sewerage Scheme has had a significant social impact. It provided a necessary amenity, essential for urban living, but more importantly it benefited the community primarily in relation to improvement in public health. The most immediate impact of a centralised municipal sewerage scheme (where reticulated sewerage services are provided in urban areas, linked via a transfer system to a central treatment facility) is the effective physical separation between people and sewage wastes. It is widely acknowledged that this separation was a major contributor to improvement in public health in urban centres at the end of the nineteenth century. A similar improvement occurred in Bathurst, where the mortality rates from typhoid fever decreased from 29 in 1910, to 9 in 1916 and to 3 in 1920 (**Ref 14**).

The Bathurst Sewage Treatment Plant, being an integral part of the Scheme, has provided a mechanism for treatment of the sewage collected. The resulting byproducts, treated effluent and biosolids, have been able to be disposed to the environment (the Macquarie River and agricultural land), in a safe and sustainable manner, consistent with evolving regulatory requirements during the twentieth century.

Mitigation of the impact of effluent discharge on the Macquarie River via treatment to progressively higher standard utilising evolving treatment technologies, has allowed continued reuse of water in the river, by farmers extracting water downstream of the plant, and discharge to Burrendong Dam, from where water is sourced for irrigation and water supplies for Wellington, Dubbo and other smaller communities. During extended periods of low rainfall, effluent discharged from the Plant comprises the major component of environmental flow in the river downstream of the Plant, highlighting the need for the Plant to produce an effluent of an acceptable quality for river discharge and downstream reuse.

Given the Plant’s significance to the Bathurst Community, Council encourages educational tours by community groups and students, enhancing understanding of the importance of the plant to the Community, as well as its acceptance of the facility.

5.2.6 Rarity

The Bathurst Sewage Treatment Plant is a rare, if not unique, example of a significant municipal facility in which the range of technologies adopted and utilised for a particular purpose during the twentieth century (in this instance sewage treatment) are represented at the one location.

5.2.7 Representativeness

The treatment technologies at the Plant represent those utilised in NSW during the twentieth century and their evolution, that is from traditional septic tanks, to trickling filtration and thence activated sludge (as Intermittent Decanted Extended Aeration and its enhancement with and without Biological Phosphorus Removal facilities).

In addition, the evolution of related technologies for effluent disinfection, sludge storage, thickening and dewatering is well represented at the Plant.

5.2.8 Heritage Assessment Under NSW Criteria

a) An item is important in the course, or pattern, of NSW’s cultural or natural history:

The construction of reticulated water supply and sewerage systems by the Public Works Department in Sydney and major country towns between 1880 and 1930 produced dramatic improvements in public health. Over this period the NSW death rate due to water borne diseases was halved and infectious disease and infant mortality rates were reduced by a factor

of ten. From 1935 similar works were funded by the Country Towns Water Supply and Sewerage Program which was administered by the Department.

The Bathurst sewage treatment plant became operational in 1916.

The developments in sewage treatment technology as demonstrated at this site, led in NSW and to an extent Australia-wide, to substantial improvements in public health, reduction of mortality from water-borne diseases, economies in constructing and operating sewage treatment facilities, and in reducing the pollution of waterways from effluent discharges.

The site is important in NSW's and Australia's cultural history in relation to the advancement of sewage treatment technology and understanding of the bacteriological processes involved.

Under this criterion the site is regarded as being of National significance.

b) An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history:

Since 1906 Bathurst Borough Council and its successors have sought to provide a fit for purpose and state-of–the-art sewage treatment facility for their community. This initially reduced mortality to a significant degree and has since ensured a healthy local environment.

In 1975 when the Public Works Department was developing a more compact Intermittent Decanted Extended Aeration sewage treatment configuration, Council was collaborative in making its treatment plant site available for research and development of a new treatment technology (IDEA), and in accepting the experimental work as part of its required augmentation. The 'reactor' that was developed became known as the 'Bathurst Box'.

Under this criterion the site is regarded as being of Local and State significance.

c) An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW:

The works on the site are the physical evidence of a high degree of technical achievement in the development of sewage treatment technology by the Public Works Department and its successor's, particularly in the period from 1975 to 2002.

IDEA systems have the relatively unique advantage of being able to be configured for influent balancing to allow wet weather inflows (up to about eight times average dry weather flow) to be attenuated and (partially) treated without bypass of untreated sewage, thus safeguarding downstream ecosystems and communities.

To date the "Bathurst Box" configuration of IDEA has been adopted by the Department to serve communities throughout regional NSW, at Penrith (IDEA BioP), in Western Australia at Yanchep, Bridgetown and Margaret River, in Queensland at Emerald, in East Malaysia at Sabah (Kudat, Kota Belud and Papar), and in China at Shanghai (Ba Du Zehn). The "Port Macquarie Tank" was a further development of the "Bathurst Box" configuration and has been widely adopted in NSW, including major plants at Picton and West Camden.

Having developed the "Bathurst Box" and "Port Macquarie Tank" configurations, research is now centred on the optimisation of design by gaining a better understanding of hydraulic design parameters and their variability under a range of operating conditions.

Under this criterion the site is regarded as being of State significance.

d) An item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons:

From 1880 to 2003 the NSW Public Works Department (and thereafter its successor, the Department of Commerce) designed and constructed numerous sewage treatment plants for country towns. The work included researching, developing, designing and implementing improved treatment methods, which has resulted in considerable health, economic and environmental benefits that are of State significance. The developments in IDEA treatment technology also enabled effluent quality to meet enhanced standards for discharges to receiving waters, thus reducing pollution, and the potential for algal blooms. The Bathurst Box was an integral component in the development of the development of IDEA technology.

Under this criterion the site is regarded as being of State significance.

e) An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history:

The site and its history are important elements in the history and development of sewage technologies in NSW and Australia. As virtually all the structures constructed since 1916 still exist, the site has significant potential for research and historical inquiry. It can demonstrate not only developments in sewage treatment since 1916, but how existing structures were adapted to continue functioning as the Plant was enlarged and updated; and how structures were retro-fitted to improve effluent quality.

Under this criterion the site is regarded as being of State significance.

f) An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history:

In possessing virtually all the structures constructed since 1916, the site is unique in NSW and probably Australia. It therefore demonstrates the evolution of treatment technologies in the twentieth century is and thus a rare resource for research into sewage treatment technologies and the types of engineering structures employed.

Under this criterion the site is regarded as being of State significance.

g) An item is important in demonstrating the principal characteristics of a class of NSW's
- cultural or natural places; or
- cultural or natural environments.

Examination of the site will demonstrate the principal characteristics of sewage treatment technologies and their evolution in NSW since 1916.

Under this criterion the site is regarded as being of State significance.

6.0 STATEMENT OF SIGNIFICANCE

The development and implementation of improvements in sewage treatment technologies at Bathurst have, since 1916, allowed the Council to meet its obligations to both service its growing population and industries and to condition the effluent produced to meet the discharge standards applicable at the time.

Bathurst Sewage Treatment Plant has been the site of extensive research into and development of modern sewage treatment technologies since the 1970s. This has resulted in significant improvements in the quality of effluent discharged, and economies in the construction and operation of treatment plants in both New South Wales and interstate.

All the structures constructed at Bathurst (since 1916) still substantially exist. The Plant therefore provides an excellent example of the evolution of treatment technologies in the twentieth century and is a unique resource for research into sewage treatment technology and the types of engineering structures employed.

The wastewater treatment technologies developed at Bathurst have resulted in significant benefits, not only for the Bathurst community but also for communities throughout NSW. These benefits have enhanced the lifestyle of communities, the prosperity of industries and the health of our environmental landscape.

7.0 PROPOSED CITATION

The wording proposed for information plaque is:

BATHURST SEWAGE TREATMENT PLANT

This treatment plant commenced operation in 1916. Additional structures were progressively constructed as the plant was enlarged and upgraded to meet increased demand and improved effluent standards. They demonstrate the evolution of sewage treatment technologies in the 20th Century and are a unique resource for historical inquiry. Research at the site has produced significant improvements in effluent quality and economies in the construction and operation of treatment plants in New South Wales, interstate and overseas.

The Institution of Engineers Australia
Bathurst Regional Council
NSW Government

8.0 REFERENCES

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APPENDIX

ADDITIONAL PHOTOS AND PLANS

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Original Trickling Filter (1929)


Chlorination House (1959)

Anaerobic Sludge Digesters, Insulated with Earth Mound (1959)

Water Make-Up and Gas Collection Tanks or Anaerobic Digesters (1959)

Sedimentation Tank with Fixed Bridge Sludge Scraper (1959)

Four Additional "Bathurst Boxes" (1979)

Mimic Electrical Control Panel (1979)

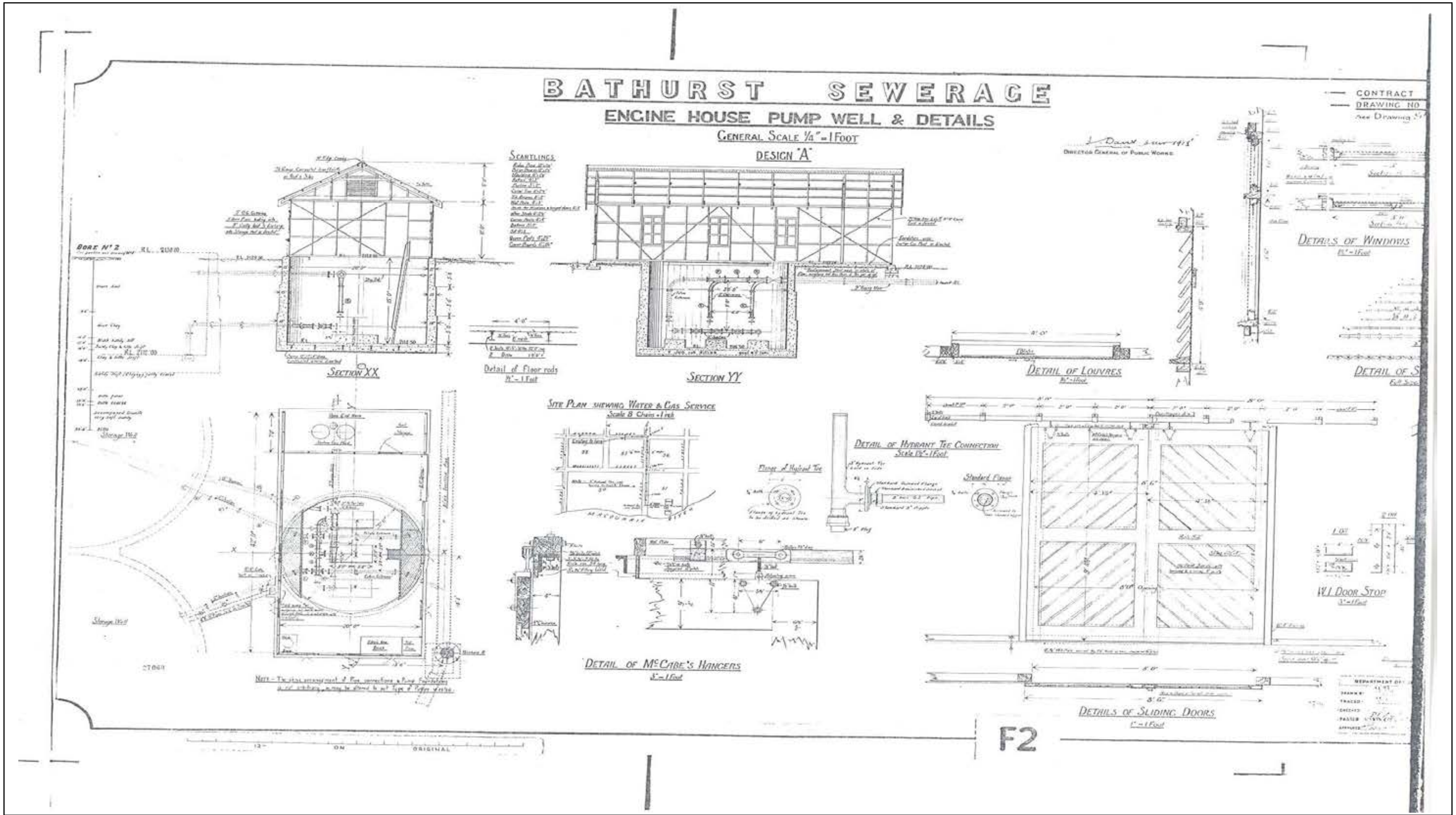
Sludge Dewatering Building, Gravity Belt Table and Press (1992)

Effluent Catch/Balance Pond with Picket Fence Flocculator (1997)

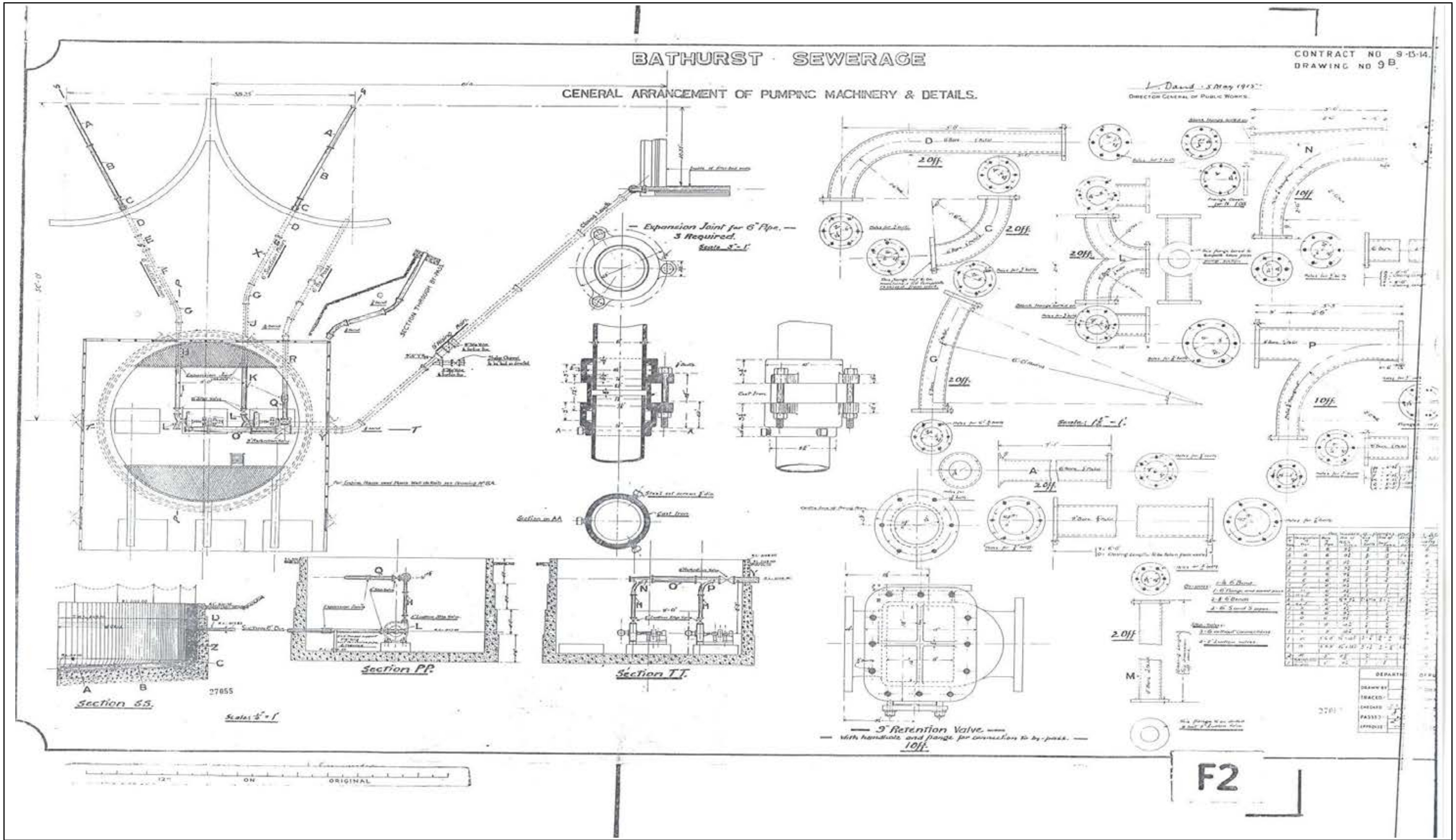
Polymer Storage and Dosing System (1992)

On-Site Testing Laboratory (1997)

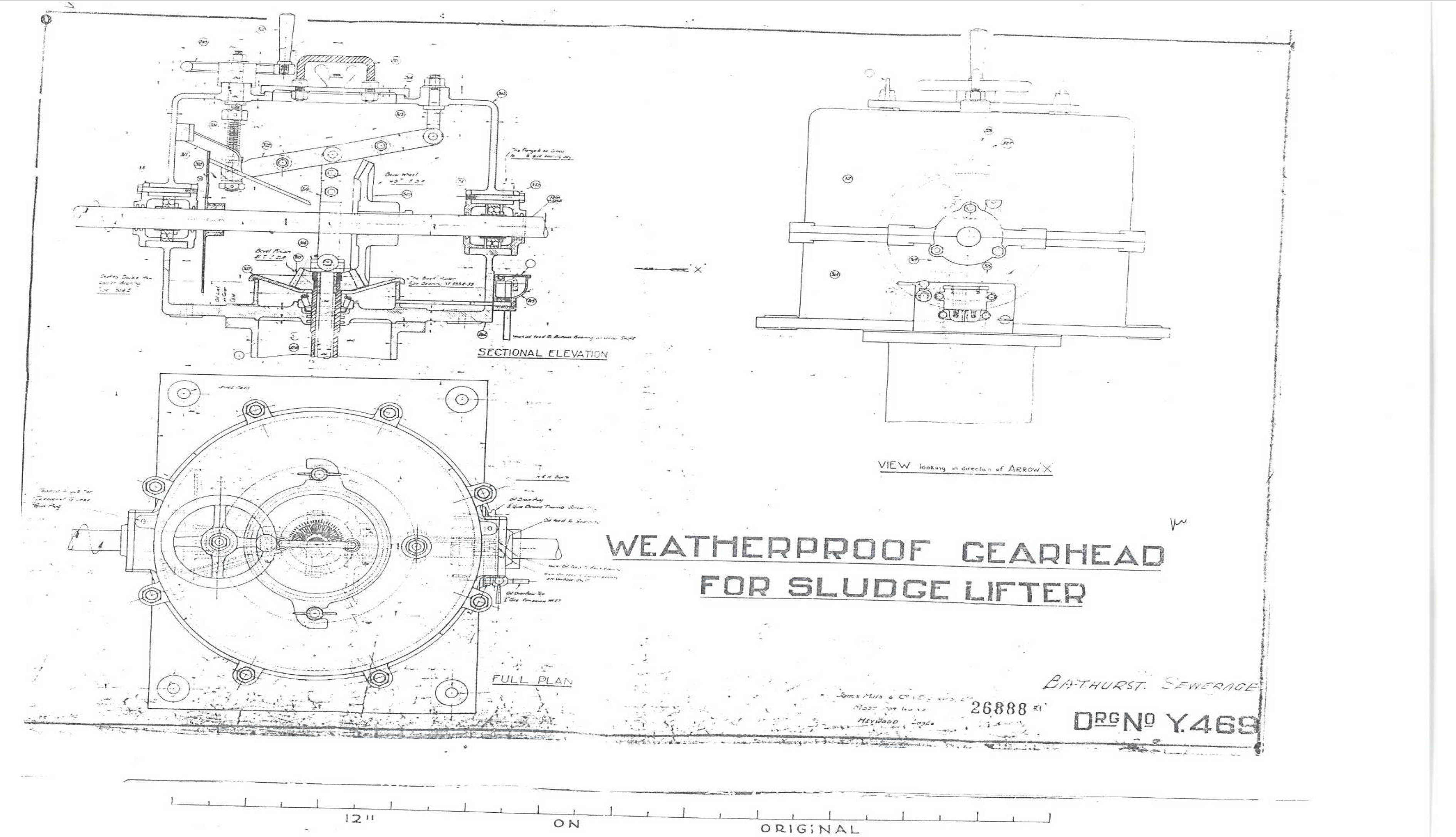
Dissolved Air Flotation Waste Actuated Sludge Thickener (2002)



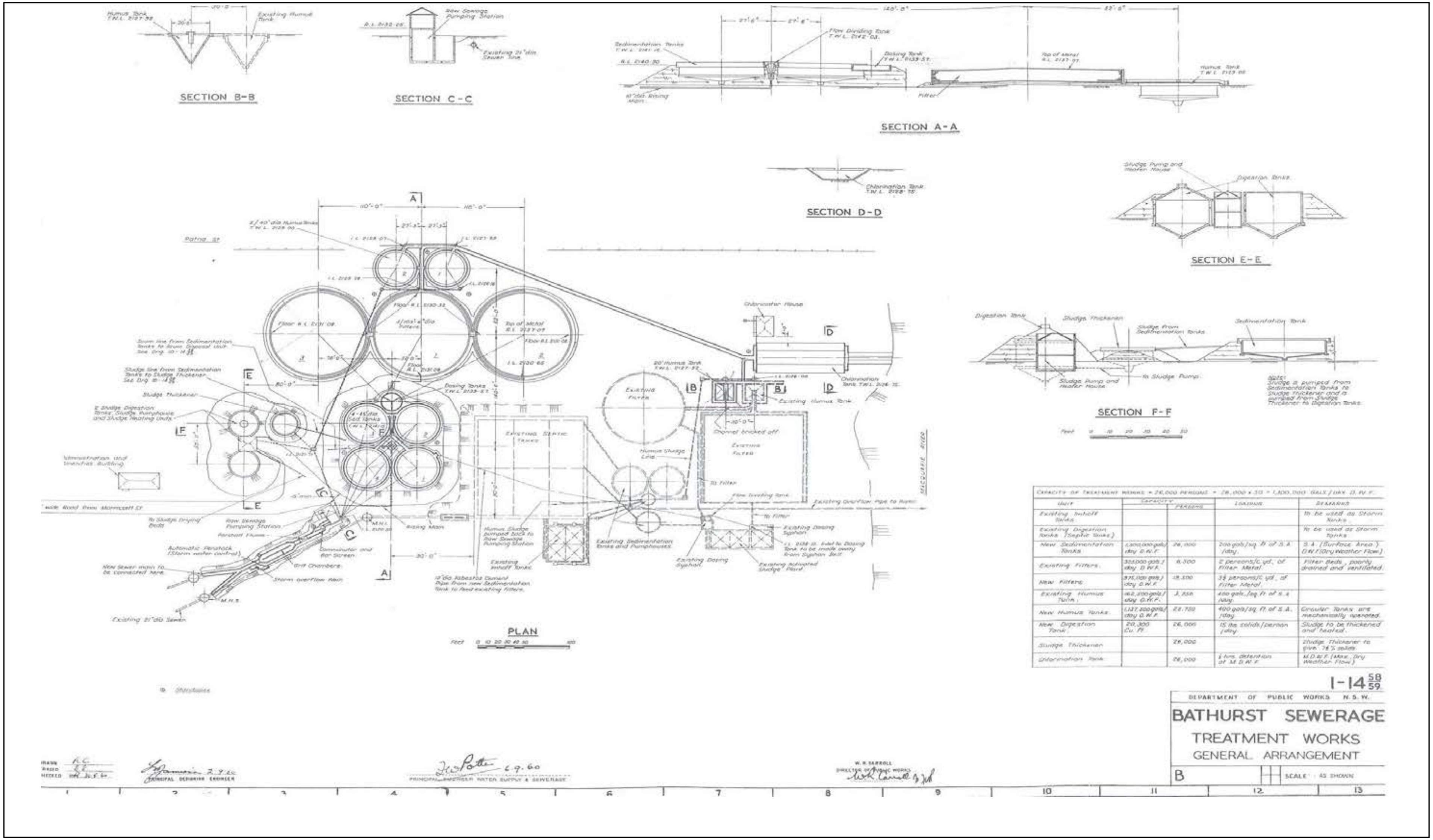
Original Influent Pump Station – "Engine House" (1916)



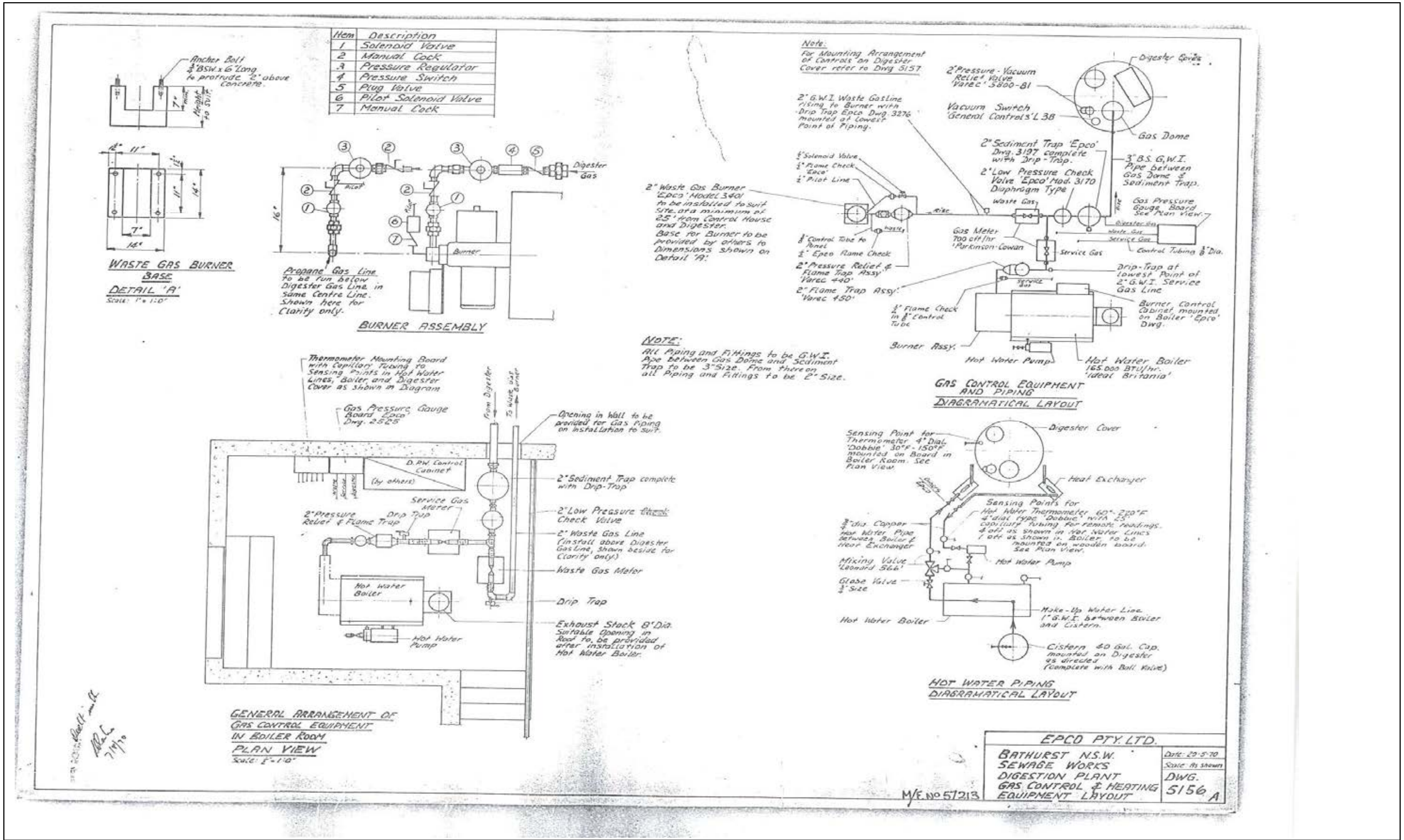
Engine House Pipework and Pump Details (1916)



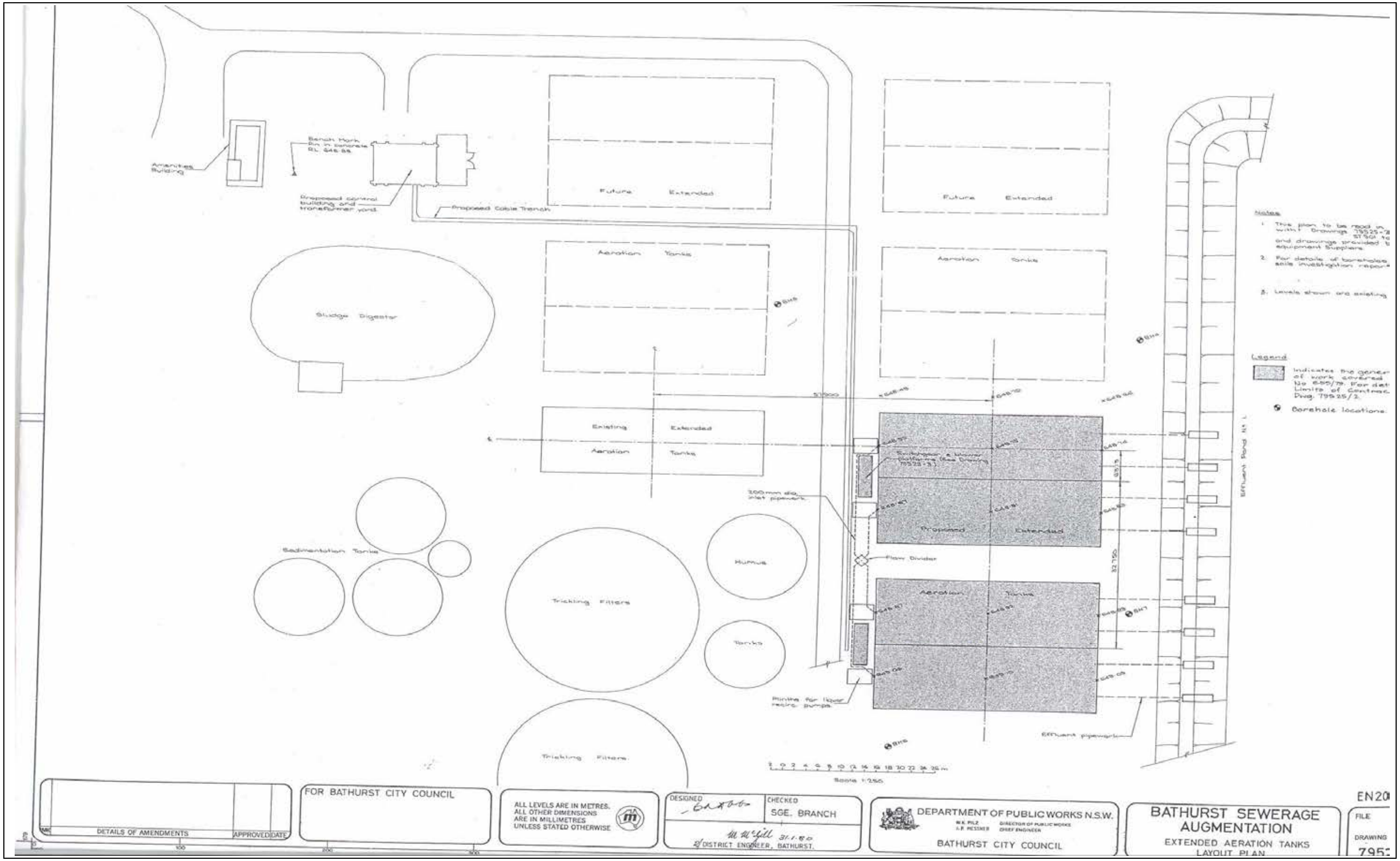
Sludge Pump Gearhead Details (1929)



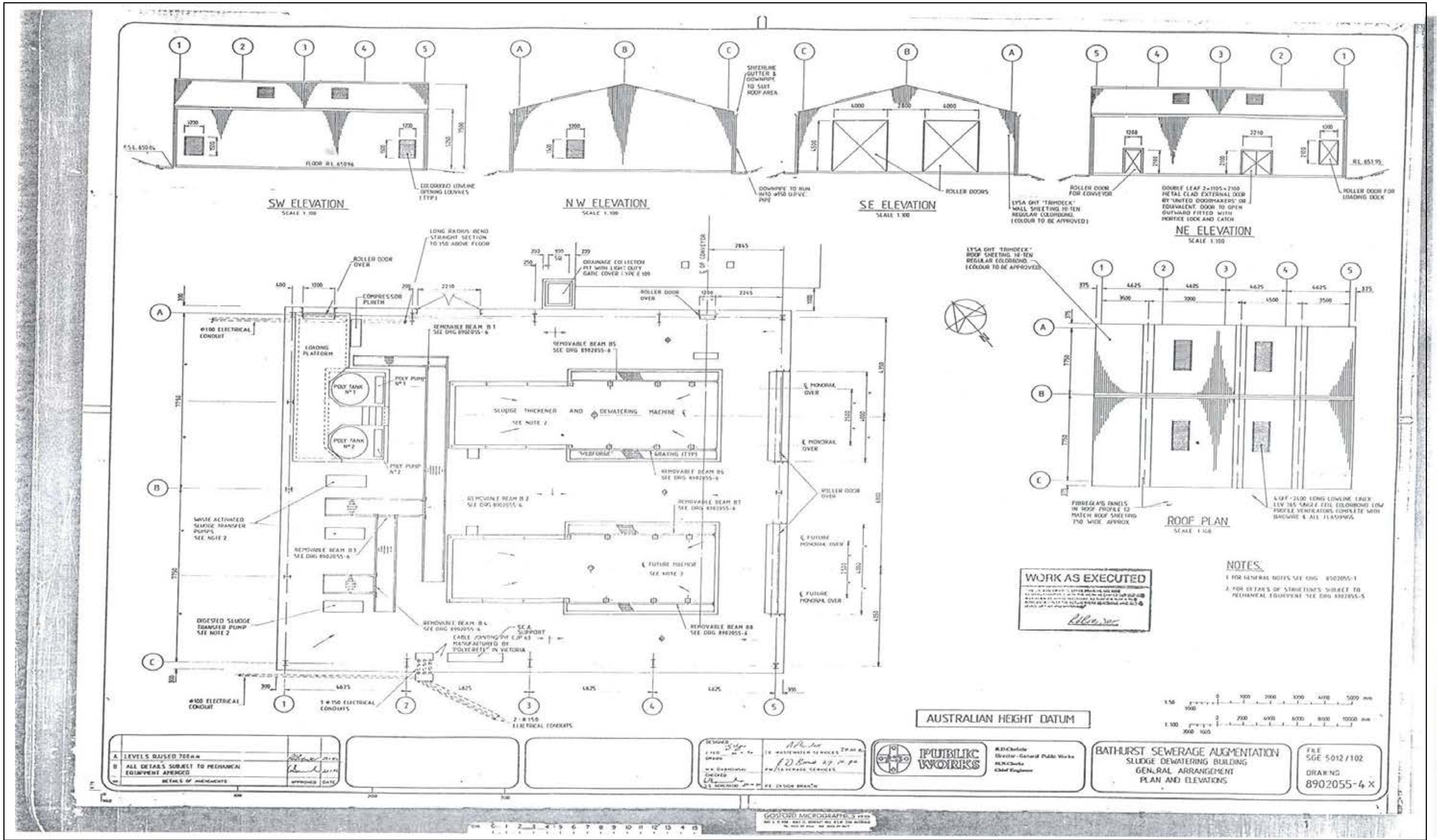
Site Plan – Trickling Filter Augmentation (1959)



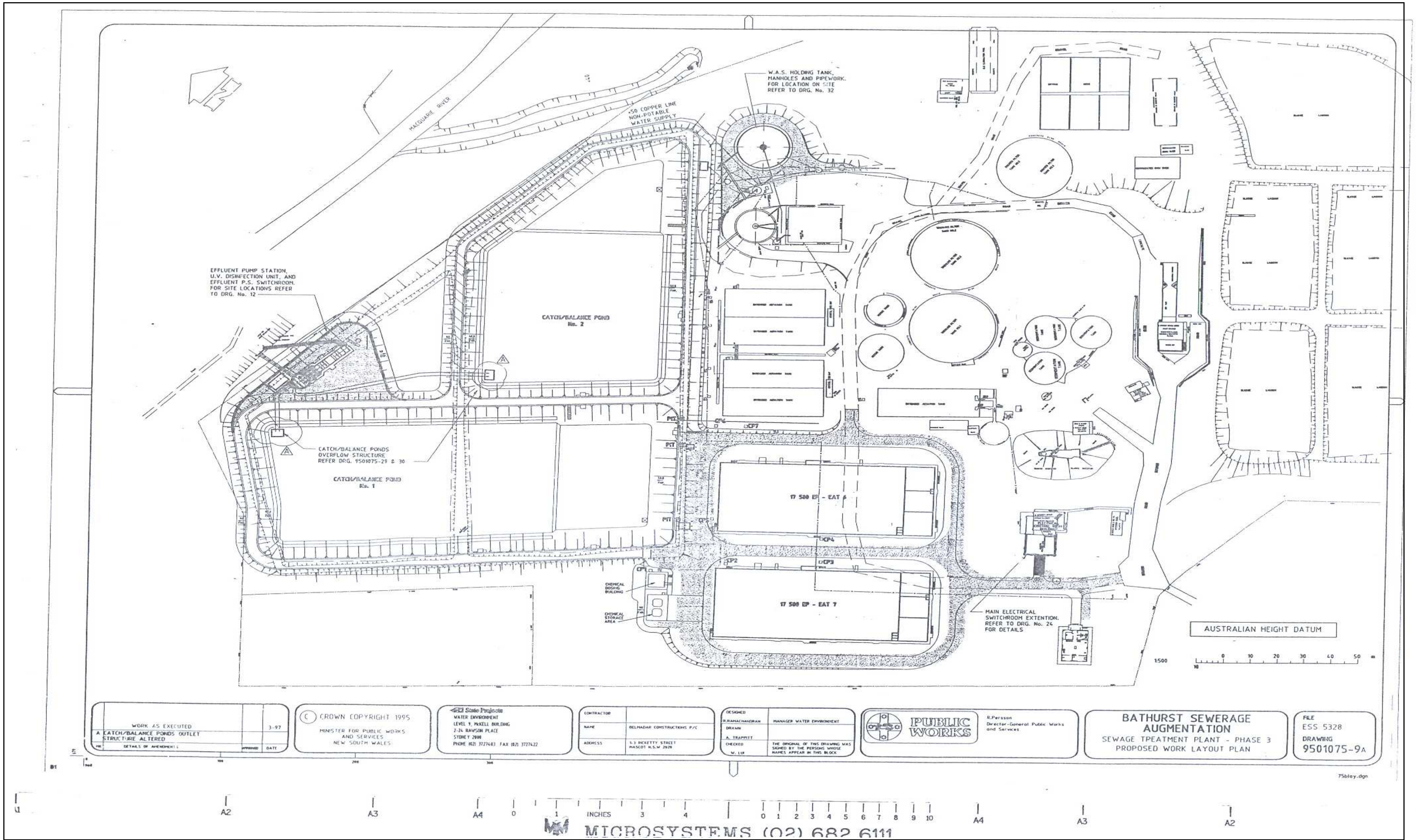
Digester Heating System – Gas Collection Schematic (1970)



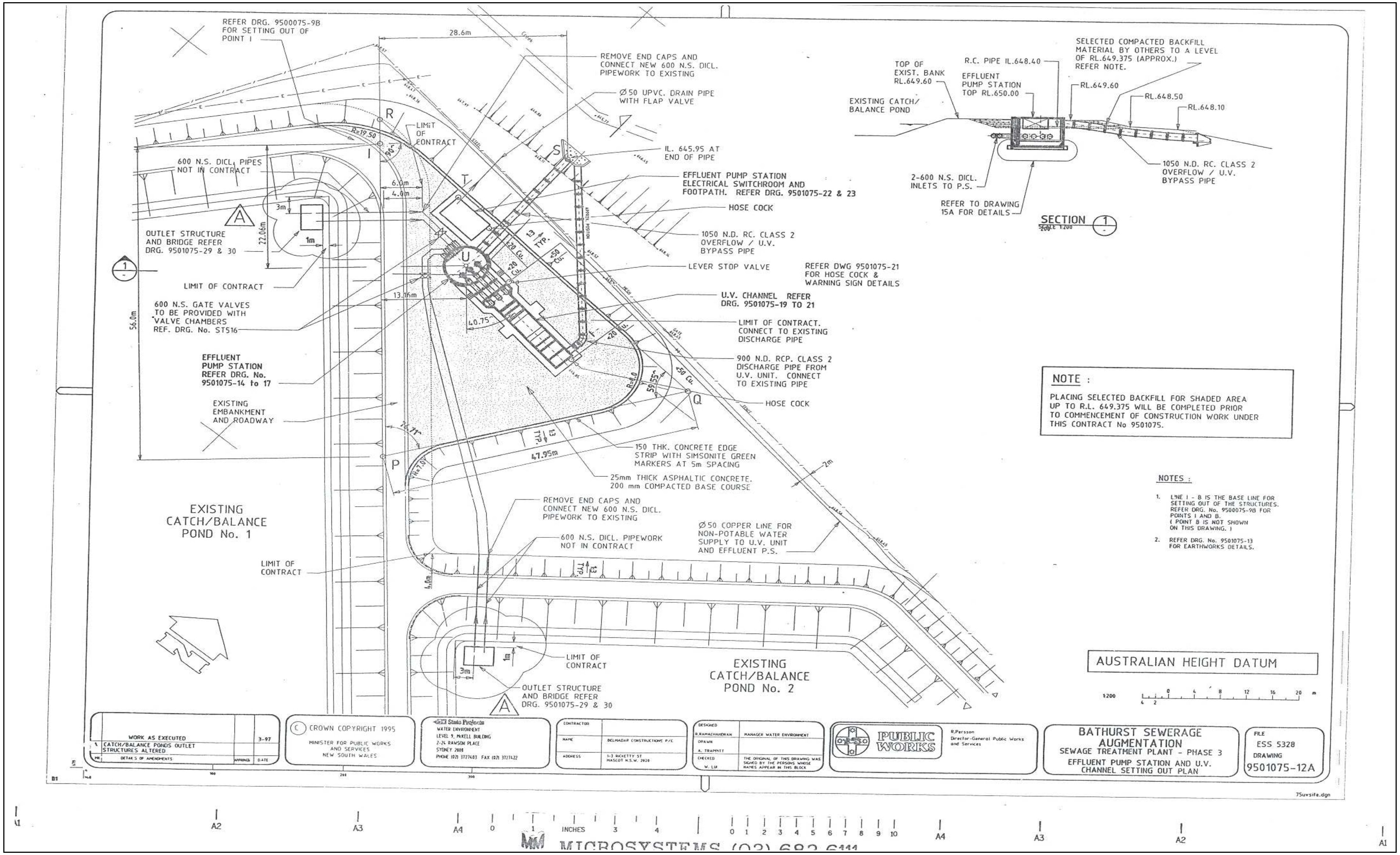
Site Layout 4 x B4000 Augmentation (1980)



Sludge Dewatering Building and Equipment Layout (1992)



B17,500 Biological Reactor, Effluent Pond and UV System Site Layout (1997)



Effluent Lift Pumping and UV Disinfection System Layout (1997)

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